Groundwater Flow Model Working Group - ISSUES and ACTION ITEMS
Sept. 22, 2017 Meeting

No.	Comments/Concerns	Initial Comment Date	Remarks/Responses	Resolu-tion	Resolu-tion Date	Category	Response to Navy
1	Describe data available and adequacy of data to achieve objectives; data quality objectives of monitoring well network; quality and limitations	Prior to Meeting # 2 (6/26/17)	This has been done in the Existing Data Report and Data Gap Analysis Report (DON, March/April 2017). In addition, additional data are being collected as part of various AOC and derivative deliverables such as the Data Gap Analysis Report, Sampling and Analysis Plan, Conceptual Site Model Development and Update Plan, Attenuation Evaluation Plan.	In Progress		CSM-Hydrogeology	
2	Anisotropy - groundwater flow paths not adequately characterized by groundwater gradient	Prior to Meeting # 2 (6/26/17)	Revised gradients are being developed based on the recent well survey and will be further evaluated as part of the synoptic water level study under transient conditions. Use of multi-level Westbay sampling points for head will also assist in this effort. Longitudinal K = 4500 ft/d (Oki);Vertical K = 7.5 ft/d. Longitudinal to Vertical anisotropy of 600:1); Oki 2005, Kh transverse = 1500 ft/day; so longitudinal to transverse = 3:1. Larger anisoptries have been used by other investigators in the area. These will be considered during model calibration.	In Progress		CSM-Hydrogeology	
3	Major hydrogeologic barriers near Oily Waste Disposal Facility (tanks?) should be described or referenced. Rainfall recharge is large where there is no caprock. 10 to 25 inches per year in Red Hill vicinity (Oki 2005; Giambelluca 1983).	Prior to Meeting # 2 (6/26/17)	We are not sure what barriers you are referring to. This will be addressed in the CSM. Note down- and cross-gradient of OWDF the presence of Honolulu Volcanics and confluence of N. and S. Halawa Streams. Infiltration will also be further evaluated.	In Progress		CSM-Hydrogeology	
4	Adequacy of sentinel well network	Prior to Meeting # 2 (6/26/17)	Will be evaluated as part of the Sentinel Well Network Plan derivative deliverable.	In Progress		Sentry Wells	
5	Resurvey well elevations	Prior to Meeting # 2 (6/26/17)	Mostly complete… additional wells being considered.	In Progress		CSM-Hydrogeology	

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6	Role of valley fill unit is a data gap	Prior to Meeting # 2 (6/26/17)	Additional investigations including well/Westbay installations, synoptic water level study, and potential seismic lines will further determine how valley fill is handled.	In Progress		CSM-Geology	
7	Assimilate and use information from two different pump tests and long-term monitoring of WLEs on-site and non-Navy wells; measurement of water quality parameters	Prior to Meeting # 2 (6/26/17)	Synoptic water level study will be evaluated as well. This can help determine anisotropies as well.	In Progress		CSM-Hydrogeology	
8	Does groundwater potentially impacted from Red Hill USTs remain in the Moanalua Aquifer only impacting the Red Hill Shaft or is there a flow component toward the Waimalu Aquifer where major pumping centers are located? The GW flow system is very dynamic in time.	Prior to Meeting # 2 (6/26/17)	GW flow contours for different seasons/years will be evaluated using resurveyed data and new information from proposed wells/Westbay pts. Use of all data, including synoptic water level measurements by USGS from 2002-2012 as well as the new synoptic study. Groundwater modeling efforts will also assist in this evaluation.	In Progress		CSM-Hydrogeology	
9	If so, is it due to unidentified subsurface structures?	Prior to Meeting # 2 (6/26/17)	What structures? The CSM will further address this. Most likely these include depth of valley fill, lava tubes in pahoehoe, and thick a'a clinker zones. The most probable pathway for a majority of groundwater flow is likely in the clinker zones.	In Progress		CSM-Geology	
10	Need to characterize nature of connectivity between the Honolulu and Pearl Harbor Aquifer Sectors	Prior to Meeting # 2 (6/26/17)	The boundary between these sectors is administrative, not hydrogeologic.	No issue		CSM-Hydrogeology	
11	North Halawa Valley should be further investigated	Prior to Meeting # 2 (6/26/17)	Yes, new monitor wells proposed and geophysical surveys being considered.	In progress (See #6)		CSM-Hydrogeology	
12	Characterization of Valley Fill (extent, and hydrogeologic properties)	Prior to Meeting # 2 (6/26/17)	Same as above.	In Progress (See #6)		CSM-Hydrogeology	

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13	*Pumping test of May 2015 shows response on Red Hill side of N (and S) Halawa valleys to pumping changes in Halawa Shaft*	Prior to Meeting # 2 (6/26/17)	Maybe, but the water level responses are complicated, and appear to be affected by Red Hill Shaft pumping too. The results are actually a little more ambiguous than has been described. The synoptic water level study will better help understand this. It is critical that all parties participate in the pumping schedule proposed by the USGS.	In Progress		CSM-Hydrogeology	
14	*Conduct a series of coordinated aquifer tests to definitely measure hydraulic connection between Red Hill area and Halawa municipal water source area*	Prior to Meeting # 2 (6/26/17)	This is part of the synoptic study.	In Progress		CSM-Hydrogeology	
15	Untested assumption: 1) Valley fill and underlying saprolite act as barriers to flow between RHBFSF and nearest BWS water supplies; no ***direct*** data	Prior to Meeting # 2 (6/26/17)	Several USGS studies indicate valley fill extends below WT. Indirect evidence (pump test response across valley fill or series of coordinated aquifer tests) can help bridge this data gap. Additional studies are being conducted to further evaluate this.	In Progress (see #6)		CSM-Hydrogeology	
16	Untested Assumption: 2) Regional flow is from NE to SW near RHBFSF; too few wells to understand flow directions and rates	Prior to Meeting # 2 (6/26/17)	Although various USGS studies show regional gradients toward the SW, additional monitor wells are being planned to collect hydraulic head data to address this.	In Progress		CSM-Hydrogeology	
17	Hunt (1996) chose North Halawa valley as a geohydrologic barrier but not on the basis of direct evidence of flow or geologic conditions	Prior to Meeting # 2 (6/26/17)	The USGS (Izuka 2012) and other USGS reports also showed valley fill extends below the water table near Halawa Shaft. Additional investigations are planned to further evaluate this.	In Progress (See #6)		CSM-Hydrogeology	
18	No borings to delineate lithology and dimensions of valley fill material; no evidence that valley fill extends below water table;	Prior to Meeting # 2 (6/26/17)	Hydrogeologic response between the units is more critical; additional borings/wells are being installed to further evaluate this.	In Progress (See #6)		CSM-Geology	

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19	Width of Halawa valley fill is exaggerated - deep valley fill is only in eastern branch of South Halawa Stream and does not extend to western branch	Prior to Meeting # 2 (6/26/17)	This comment is not clear. Deeper valley fill exists toward the west in Halawa Valley. To the west, near the confluence of North and South Halawa valleys, the H-3 boring logs show deeper valley fill that ex to further evaluate this tends below the water table. Additional investigations are underway to evaluate valley fill.	In Progress (See #6)		CSM-Geology	
20	Model should not include valley fill barriers till further evidence of barrier; model should attempt to calibrate without barrier and if possible, then use that model	Prior to Meeting # 2 (6/26/17)	Valley fill permeabilities will initially be assigned the same permeability as basalt until geologic/hydrogeologic data can be better evaluated in this regard. Investigations are planned to further evaluate this.	In Progress		CSM-Hydrogeology	
21	Need one or more monitoring wells to be installed along northwesterly direction from RHBFSF; to estimate change of flow direction and rates from RHFSF toward Halawa shaft during pumping of Red Hill and Halawa shaft	Prior to Meeting # 2 (6/26/17)	Additional monitor wells are being planned to collect hydraulic head data to address this issue.	In Progress		CSM-Hydrogeology	
22	Regional gradient to southwest is contradicted by TEC 2010 letter report	Prior to Meeting # 2 (6/26/17)	We recognize that there are various interpretations of groundwater flow gradients in previous reports. New data and survey information will resolve this.	In Progress (see #8)		CSM-Hydrogeology	
23	Describe CSM elements - historic data; quality of information; format of deliverables	Prior to Meeting # 2 (6/26/17)	This is being done and is part of the CSM Development and Update Plan.	In Progress		CSM-Hydrogeology	
24	Define boundaries of site, study area and modeling domain	Prior to Meeting # 2 (6/26/17)	This was discussed during meetings 2 and 3 and has been addressed.	Resolved		Flow Model	
25	BCs should reflect real-time measurement of heads	Prior to Meeting # 2 (6/26/17)	The objective is not to evaluate real time water level changes. Boundary conditions for the model will be evaluated from evaluation of recent water level data.	In Progress		Flow Model	

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26	Modeled BCs should be far enough to not impact Halawa Shaft pumping or have flow directions toward Halawa shaft from RHBFSF	Prior to Meeting # 2 (6/26/17)	We have model BCs far enough to not impact Halawa Shaft pumping.	Resolved		Flow Model	
27	There are anomalously high water levels within the Red Hill Ridge area which respond to pumping stresses likely from the Halawa Shaft. How will model use this information?	Prior to Meeting # 2 (6/26/17)	New precision surveying has been done to establish more accurate groundwater level elevations, and integration of the synoptic water level study will also help resolve this issue. The numerical model will be calibrated to match the groundwater levels.	In Progress		Flow Model	
28	Delineate perched water conditions at Red Hill in the basalt and valley fill units	Prior to Meeting # 2 (6/26/17)	These conditions (where they may be found) are being integrated into the CSM at Red Hill and are being evaluated through the monitoring network at the prison beneath South Halawa Valley. As appropriate, this will be considered in the model for recharge.	In Progress		CSM-Hydrogeology	
29	Suggest using recharge values already calculated by USGS	Prior to Meeting # 2 (6/26/17)	Infiltration testing is planned for Red Hill to further evaluate this near the source zone. The USGS recharge calculations refer to GW recharge rates presented as maps in Engott 2015 and Izuka 2016. Impacts of the other features noted are not included in the USGS calcs. The modeling plan is to start by inputting the USGS recharge rate map data to the model, then adjusting the rates locally to account for other features such as saprolite cap above Red Hill, cement plant, quarry, lined stream channels, etc.	In Progress		CSM-Hydrogeology	
30	Evaluate past modeling efforts	Prior to Meeting # 2 (6/26/17)	Past modeling efforts are being evaluated and are summarized in the GWMEP. We are also conducting more evaluations such as mass balance components as new data become available.	In Progress		Flow Model	

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31	"Dominant GW flow direction is to northwest, not toward Red Hill shaft to southeast"	Prior to Meeting # 2 (6/26/17)	See Response #8.	In Progress (See #8)		CSM-Hydrogeology	
32	Rotzoll and El-Kadi (2007) model not adequately calibrated for flow directions due to survey issues.	Prior to Meeting # 2 (6/26/17)	We are not depending on the 2007 model and are resolving survey issues.	In Progress		Flow Model	
33	Questions about flow directions and rates between Moanalua and Halawa valleys; use defensible approach of Oki (2005) to address this data gap; correcting for head errors showed flow direction to northwest (and not from NE to SW) in area of RHBFSF	Prior to Meeting # 2 (6/26/17)	See Response #8.	In Progress (see #8)		CSM-Hydrogeology	
34	Fig 3 on pg 38 of Mink, 1980 "State of the relationship between the Groundwater Resources of Southern Oahu" shows GW flow direction from Red Hill toward Halawa Shaft	Prior to Meeting # 2 (6/26/17)	This map in Mink 1980 only shows regional dashed water level contours with no data points at all in our area of interest!	Resolved (See #8)		CSM-Hydrogeology	
35	Heads at OWDFMW01 are unconfined basal aquifer and not confined; confining units are about 1000 feet away and no upward gradients or "major hydrogeologic barriers"	Prior to Meeting # 2 (6/26/17)	Individual massive basalt layers can also create localized confined aquifer conditions.	Resolved		CSM-Hydrogeology	
36	Limitations and Sensitivity of model; approach to improve model; professional judgements	Prior to Meeting # 2 (6/26/17)	Comment not clear, but the GWMEP describes the technical approach for the modeling and includes a sensitivity study. Of course, we always describe model uncertainties and limitations in modeling reports.	Resolved		Flow Model	

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37	Gather input at important decision points from stakeholders and regulators	Prior to Meeting # 2 (6/26/17)	That's the point of having GWFM working group meetings and detailed review and comment of draft documents before final distribution. In addition, it is incumbent on all stakeholders to point out available information sources (including well data) and help with obtaining all pertinent data.	Resolved		Other	
38	Simulate drought scenario; simulate distribution of pumping and location of hypothetical new well in future scenario; get input from stakeholders on this	Prior to Meeting # 2 (6/26/17)	The draft GWMEP states "This modeling will help ascertain potential risk to water supply as a result of a potential range of releases from the Red Hill Bulk Fuel Storage Facility under a range of reasonable pumping conditions within the model domain." We would welcome input from BWS on future well locations.	In Progress		Flow Model	
39	Uncertainty about groundwater flow paths (and about gradients)	Prior to Meeting # 2 (6/26/17)	See Response #8.	In Progress (See #8)		CSM-Hydrogeology	
40	Free phase may be near gw interface (RHMW02 exceeded 1% limit of 45 µg/L)	Prior to Meeting # 2 (6/26/17)	COC concentrations are a good indication of this when effective solubility levels are reached. Not sure what the conc value is in reference to? These issues are further addressed in the Attenuation Evaluation Plan.	In Progress		Nat Atten	
41	early detections of a thin free product layer were followed by a long history of no detections.	Prior to Meeting # 2 (6/26/17)	We don't recall seeing any free product layer detection. In 2007-08 we recall a sheen was reported. Not sure what the point is?	?		Nat Atten	
42	Transport modeling uncertainty in porosity (0.05 used for 2007 F&T model consistent with SWAP model; inverse modeling estimated 0.031. Consider this in interpreting results	Prior to Meeting # 2 (6/26/17)	This will be considered in interpreting results.	Resolved		F&T Model	
43	Perform tracer test	Prior to Meeting # 2 (6/26/17)	We are in discussion with Bob Whittier and Don Thomas on this subject and are initially focused on natural tracers.	In Progress		CSM-Hydrogeology	

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44	Include releases to GW from envelope surrounding the tanks	Prior to Meeting # 2 (6/26/17)	We will be evaluating a range of potential release scenarios from the tanks.	In Progress		F&T Model	
45	Consequences of future potential releases; fraction NAPL immobilized in vadose zone and fraction expected to reach water table	Prior to Meeting # 2 (6/26/17)	Will depend also on potential release volumes. Various LNAPL scenarios will be evaluated.	In Progress		Nat Atten	
46	Evaluate mechanisms expected to accompany different sizes of future potential fuel releases	Prior to Meeting # 2 (6/26/17)	To the extent that this is related to LNAPL transport and natural attenuation, this is covered in the Attenuation Evaluation Plan.	In Progress		Nat Atten	
47	Uncertainties are too great; degree of calibration unreasonable; mixing of recent and legacy contamination; unknown footprint of source area; unknown sorption rates; unknown subsurface structure geometries (anomalous WLEs); *produce a set of probability realizations for likely transport paths and velocities*	Prior to Meeting # 2 (6/26/17)	The data from new wells, precision survey, and synoptic study should reduce these uncertainties a great deal. In addition information from the attenuation study will help resolve this. The CSM will integrate older and newer data to reduce uncertainty as well. We will evaluate if a probabilistic analysis is warranted against other approaches such as bounding analyses.	In Progress		CSM-Hydrogeology	
48	Test GW samples for other fuel additives	Prior to Meeting # 2 (6/26/17)	This has been addressed in the Attenuation Evaluation Plan.	In Progress		Nat Atten	
49	Examine relationships between soil vapor concentrations and groundwater heads and chemistry	Prior to Meeting # 2 (6/26/17)	These data will be evaluated for this purpose. This has been addressed in the Attenuation Evaluation Plan.	In Progress		Nat Atten	
50	Is source vapor, LNAPL or dissolved contaminants in infiltrating water or a combination	Prior to Meeting # 2 (6/26/17)	This is being addressed in the Attenuation Evaluation Plan.	In Progress		Nat Atten	
51	Lateral migration of LNAPL through vadose zone could affect water quality in streams	Prior to Meeting # 2 (6/26/17)	Very doubtful for Red Hill; however, the CSM and Attenuation Plan should address this. However, releases from the prison may result in stream impacts.	In Progress		Nat Atten	

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52	Assess degradation rates	Prior to Meeting # 2 (6/26/17)	This is being addressed in the Attenuation Evaluation Plan.	In Progress		Nat Atten	
53	Install vapor monitoring points to evaluate vapor plume over depth and time; evaluate likely LNAPL pockets	Prior to Meeting # 2 (6/26/17)	Vapor sampling points exist now, and this is being addressed in the Attenuation Evaluation Plan. In addition, a Westbay is planned to be installed which will have the ability to sample soil gas in the unsaturated zone.	In Progress		Nat Atten	
54	Evidence of degradation (levels of oxygen, carbon dioxide, degradation compounds in vadose zone	Prior to Meeting # 2 (6/26/17)	This is addressed in the Attenuation Evaluation Plan.	In Progress		Nat Atten	
55	How will first order rates be selected and validated	Prior to Meeting # 2 (6/26/17)	This is addressed in the Attenuation Evaluation Plan.	In Progress		Nat Atten	
56	Too many undefined variables to do decay calculations with confidence; do probabilistic analysis using different velocities and directions	Prior to Meeting # 2 (6/26/17)	This is addressed in the Attenuation Evaluation Plan; probabilistic analysis will not add useful information.	In Progress		Nat Atten	
57	Do simulation without decay also	Prior to Meeting # 2 (6/26/17)	Particle tracking will not consider decay. Decay rates from the attenuation study will be utilized in the model.	Resolved		F&T Model	
58	List of remedial alternatives is incomplete: Include steam, heat enhanced SVE; bioaugmentation, wellhead treatment; vacuum-enhanced NAPL recovery; stabilization, interception barriers	Prior to Meeting # 2 (6/26/17)	This will be addressed in the future Remediation Report deliverable.	Future Effort		Remediation	
59	Analysis of combined technologies	Prior to Meeting # 2 (6/26/17)	This will be addressed in the future Remediation Report deliverable.	Future Effort		Remediation	
60	Integrate risk assessment, data collection and models to establish risk based criteria for Groundwater Protection Plan	Prior to Meeting # 2 (6/26/17)	This is part of the forthcoming Risk-Based Decision Criteria Development Plan derivative deliverable.	In Progress		Risk Assessment	

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61	Use iterative approach between data collection and analysis/modeling	Prior to Meeting # 2 (6/26/17)	This is part of our modeling approach.	In Progress		F&T Model	